Perceptions and Responsiveness to Intimacy with Robots; A User Evaluation

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Abstract. In human-robot interactions research it is significant to question what measures humans will take to contest the challenges and what will become of them. Levy hypothesizes that robots will stimulate human senses with their many capabilities and humans will accept them as intimate companions because the human perception of intimacy will transform to accommodate various nuances. However, the question remains, how much humans understand and accept intimacies with robots. We argue that perceptions of human-robot interactions (HRI) and intimate interactions with robots have a certain impact on how individuals comprehend intimacies with robots. Long term contact with robots, in terms of robotic technology and conversations, will change our views and practices regarding intimacy with robots. Our study revealed that lack of awareness of the potentials of future AI robots has created a fear; fear of losing both tangible, intangible, and the sense of dominance. Yet, our participants' intimate interactions with robots produced varying degree of responses that, we believe are revealing another scope of human-robot interactions.

Key words: Robots, Intimacies, Human-Robot Interactions, Perceptions, Touch

1 Introduction

The widespread progress in human-machine interaction technologies for the last two decades strongly impacted everyday lives of people who are surrounded by these technologies (communication devices, wearable devices, etc.), and whose various engagements are mostly facilitated by them. Human-robot interactions in particular have turned a new page with social robots, creating possibilities for artificial companions, thus exploring new topics of discussion. David Levy [1] said "The more humanlike a robot is in its behavior, in its appearance, and in the manner with which it interacts with us, the more ready we will be to accept it as an entity with which we are willing or even happy to engage". He was discussing the prospect of robots as artificial intimate partners for humans, which as an idea was provocative, and created a plethora of criticism, both positive and negative. However, his controversial approach has created a platform for discussing the future of robotics in a different setting; an entity advanced in artificial intelligence. The prospect of robots with AI, as Levy mentioned above, identical to humans in behavior, interactions, and appearance generated a topic of conversation

regarding the problematic of cohabitation.
Future robots are going to be more than tools; instead they are walking, talking, and thinking parts of our living, and our experiences. Invariably, human acceptance of artificial, intelligent, and human-like entities will be a challenging process. However, the human will be strongly motivated to connect with robots intimately, because a large number of robots of various capabilities are going to move into our vicinity, compelling us for closer communications. Like mobile phone technologies, robotics will be constantly upgrading with an industry that is reaching towards new potentials, and demanding customers who are invariably intimately attached to their robot companion.
The prevailing arguments will continue to evolve; from morality of a robot companion to the rights over/of a robot. Our questions will largely be focused on the future of humankind as individuals and intelligent collectives. Although some of the scenarios involving AI and robotics might appear similar to science fiction, they are feasible, requiring improvement in a number of spheres. It will only be a matter of time until our communications with robots become similar to human-human interactions. Thus, it is imperative to concentrate on studying different aspects of human-robot relationships. It will prepare every structure of the society to address numerous challenges these new interactions bring forth. Besides, it is necessary to create a platform for robust conversations on human-robot relationships before the robotics industry overwhelms us with products and services.
This study is aiming at facilitating that platform for conversation. Our objective is to evaluate the perceptions and physical responses to intimacy with robots. Our study concentrates on 1) understanding the perception of being associated with robots, and 2) the physiological responses (EDA measures) to interacting with robots. Through perception we are determining the subjective interpretations of human-robot connections, and EDA measurements are giving us evidence to how people physically react to intimacy with robots. Our results showed that, even though our study sample revealed a high awareness of robots, they reveal considerably less preference towards the idea of been intimate with robots. Physiological reactions have shown that our study participants experienced higher stimulation from the visual stimuli of the robot moving to music, rather more than haptic stimuli, such as touching the head or backside of the robot.
We understand that the perception and physiological responsiveness as key aspects in encouraging and developing communications and implications of human perception and responsiveness on human-robot interactions. Hence, the key novelty we presented in this research is the concept of intimacy with robots, in a variety of different roles and scenarios; as domestic help, companions, caregivers, comrades, lovers, true other halves, sexual partners, etc. within the framework of perception and responsiveness. Onwards, in this paper, we will discuss different studies on human-robot relationship platform. We will present our objectives, methodology, and follow it with our study results. We will discuss our study results lengthily and conclude the paper.

2 Background

Human-robot interactions are basically understood as part of the human-machine interactions. The story is that humans will design and produce robots to make their everyday life convenient and efficient. Robots are naturally part of human day to day living, from birth to death, yet they have been designated a position in the periphery, not in the midst of human living. Robots in the future, despite their peripheral positioning, will be common, not merely performing routine jobs, but also be responsible for major tasks, executing them effectively and efficiently. No matter where humans position them, they will create their own space, and the challenge will be the human acceptance of their spatiality.

Naturally, our relationship with robots will evolve with time, due to the amount of communication and familiarity. Whether human relationships with robots can provide for the good life is one of the focal points of discussion, with the central argument vying that the good life will be obliterated by the moral dilemma presented by these relationships. The constant criticism against deeper human-robot connection is part of the technological determinism and singularity. The fear of social and cultural changes, with the assumption that society and culture is not fluid, drives some people to understand that technological advancement determines the social and cultural values [2]. Simultaneously, people fear that, with time, technological advancement, specifically artificial intelligence, would be out of control of humans, and that will bring unimaginable changes to human nature itself [3].

While these forecasts paint a picture of gradual doom, a study found that individuals relate social rules and expectations to machines and exhibit certain socially acceptable behavior towards machines [4]. Why should we be concerned with human association with machines or computation, when we are as Sherry Turkle [5] said, ‘increasingly nonchalance about machines in our everyday lives? We have accepted the human-machine, human-robot, and human-computer interactions, albeit lots of remonstrations, without much thought to the simple fact that a few decades ago we were hardly at this threshold of development. Our acceptance of new developments did not arrive from the understanding that technology has a certain sequential inevitability, but from experiencing them, and adapting them to everyday living. What we deemed as good life has changed historically. It faced technology in different centuries, in different civilizations, in different continents. Change crushed the humans on one side while revving them to rise again with a different perspective on good life.

When Asimov [6] famously made laws of robotics, he was clearly ascertaining the supremacy of humans over robots, which is a moral and sentimental association with humanity. It created a moral legitimacy for robotics, because those laws fundamentally created a hierarchy of existence, where our basic fear of robots rest. Asimov not only introduced the laws to protect humans, thus limiting the production of artificial cognitive capacities in machines, but also assumed that robots with high AI will have the capability to comprehend the superiority of humans. Our lack of faith in technology is essentially evolving from our faith (lack thereof) in ourselves, rather than the inevitability of technology.

Describing Deb Levines position on online relationships, where the author realizes them as a valid substitute for traditional relationships, Levy [1] claimed that human-robot relationships could be viewed on equal grounds. This is a moral dilemma that unsettles the everyday selves. As Piarra, N., et al. [7] concluded in their paper, lay persons‘ perception of a robot is that of a mechanical body, which fundamentally presents a predicament when deliberating about relationships. Human relationships or what Levine was describing as a traditional relationship are multi-faceted with many nuances in each interaction. Whether a robot can become similarly complex and intricate is a dubious status. Since a robot acquires its information through various means and it will miss the fluid relationships between subjects, thus it is incapable of developing a knowledge of common-sense claims Nowachek [8], emphasizing on the idea that learning occurs as a function of being in the world. In that regard, a robot can be a substitute to a traditional relationship, however the fluidness and the complexities of a relationship will not be part of that substitution; instead it will be a leaner, non-compromising exchange. Subsequently comes the questions related to the association between a machine and a substitute. Thus, are machines really a substitute? In most instances it is a yes, because we rely on machines to an extent that is alarming, yet fathomable. Will people, who emphatically declare robots as machines, view robots as substitutes for traditional methods of interacting?

Graaf [9] says that our interactions will have different meanings when there are with social robots. For one thing, the relationship between human and robot would, to a greater extent, be unidirectional, which produces chasm of expectations and unhealthy aspects of reliance. Social and cultural aspects are an integral part of this relationship, and highly contested, as those are built on values that are part and parcel of human lives. Kaplan [10] tried to measure the acceptance of robots by eastern and western cultural spheres, and concluded that they adopted different approaches towards robots; while West fervently embraced and involved with technology, and human-robot interactions, their attitude is generally distress for robotics. Contrastingly, the author has claimed that Japan, representing the East, embrace technology and human and robot interactions with a certain distant attitude and robots do not bother them extensively. Although the premise of this study raised issues, the moral and cultural perspective strongly decide on the human-robot relationship.

When the academic community measured in on the role of a robot companion [11], the human experience of psychological intimacy with robots through the physical intimacy [12], human physiological response to intimately touching a robot [13], a systematic survey of the acceptance of sex robots [14] and aspects that influence the purchase of sex robots [15] are (to name a very few) contributing to a greater discussion that would contain what could be described as an emerging phenomena. It is important to emphasize that greater contribution in terms of assessment of social impact and risk management are required for a robust coexistence in future.

3 Methodology

3.1 Objectives

Our objectives are fundamentally to understand the perceptions of being intimately associated with robots and physiological reactions to close interactions with robots. Through the perception we are aiming to determine the interpretations of human-robot interactions and through the measurement of electrodermal activity (physiological responses), we are expecting to interpret the individual responses to physical interactions with robots. Although we understand that a correlation between perception and physiological response is not reasonable to measure considering the differences in methods, we will still discuss the differences on an abstract level. Both of these measures will reveal the dynamics and trajectories of human-robot intimate interactions.

3.2 Participants

A total of 20 participants of the age of 20 and above participated in this study. All participants are from different nationalities and ethnic backgrounds (Refer to Table 1).

Table 1: Participants Data

Participant Number	**Age**	**Nationality**
Participant 1	46-50	Nigerian
Participant 2	21-25	Malaysian
Participant 3	26-30	Singaporean
Participant 4	21-25	Malaysian
Participant 5	21-26	Malaysian
Participant 6	31-35	Malaysian
Participant 7	21-25	Malaysian
Participant 8	21-26	Malaysian
Participant 9	21-27	Malaysian
Participant 10	21-28	Malaysian
Participant 11	26-60	Malaysian
Participant 12	21-25	Malaysian
Participant 13	25-30	Malaysian
Participant 14	21-25	Malaysian
Participant 15	21-26	Malaysian
Participant 16	21-27	Malaysian
Participant 17	26-30	Malaysian
Participant 18	31-35	Nigeria
Participant 19	31-35	Iranian
Participant 20	21-25	Malaysian

3.3 Study Protocol

Study 1 - Study 1 consisted of a questionnaire that was presented to participants who answer position questions related to human-robot relations. They were asked to contemplate on those questions and give binary answers. In this we adapted the Guttman scaling method, which is “applied to a set of binary questions answered by a set of subjects” [16]. Guttman scale is cumulative, thus the questions are progressively challenging. The process could generate contradictory answers and reveal certain inconsistent positions of the participants. In a pilot study [17], we discussed this stage of the test using both male and female participants. Through these questions we urged participants to express their perception of representations, while with questions, we stimulated scenarios both personal and impersonal. We also conversed with participants informally to clarify some of the answers.

Study 2 - Following Study 1, the second stage of this study measured the physiological reaction to close interactions with a robot. We used a commercially available biomedical equipment to measure electrodermal activity[1].

3.4 Study Structure

Study 1 - The questionnaire consisted of five dimensions, each dimension pertaining to a particular aspect of robot or a particular responsiveness towards the existence of robots. The objective here is for participants to construct their own scenarios with their awareness of robots, whether those robots are industrial arms, humanoid robots, domestic robots, or future high-tec robots. They are encouraged through a number of questions that associate robots with humans, stimulating their minds to take a position on variety of human-robot interactions. The answers to each dimension will be examined to understand individual positions. Awareness is the first dimension, which is aiming to understand the level of awareness of robots in the day to day living and the degree of acceptability of that awareness. The second dimension is Association, which is aiming to comprehend the personal relations and associations individuals prefer to build or imagine preferring to build. Enjoyment, as the third criterion, is aiming to understand the individual pleasure and entertainment with/from robots. Attraction, as the fourth dimension, is measuring the perception of individual attraction to robots. The last dimension is Intimacy, where the individuals are requested to imagine intimacy (in terms of romance, love, and sex) with robots.

Study 2 - This experiment measured electrodermal activity (EDA) using a commercially available toolkit while the participants were engaged in designated interactions with the robot Alpha 2[2]. The test started with relaxation of the participant with relaxing audio and visual stimuli, after which the participant interacted with the robot on predetermined stimuli, which were both visual and tactile. The predetermined protocols were designed to roughly collaborate with the dimensions discussed in study 1. While the test began with relaxation, it concluded with a high excitement point; a bursting of a balloon. The objective was to position all EDA results between the relaxed as the lowest reading of EDA to bursting balloon as the highest reading. Each interaction was for 30 seconds, with a 60 second relaxation period in between (refer to Table 2).

4 Results

4.1 Study 1 -

This study, as we experienced in our pilot study [17], garnered high positive results for particular questions. The first item out of two items in awareness resulted in 91.25% of positive answers. However, item 2 showed only 53.5% average of positive answers.

[1] http://bitalino.com /en/board-kit-bt

[2] Alpha 2 https://www.indiegogo.com/projects/alpha-2-the-first-humanoid-robot-for-the-family-social

Table 2: List of Test Protocols

No	Protocol	Time	Dimension
1	Relaxation audio/video relaxation clip	30sec	Lowest point
2	Looking at the robot robot sitting down	30sec	Awareness & Association
3	Looking at the robot robot standing up	30sec	
4	Watching robot moving robot walking	30sec	
5	Watching robot dancing 1 robot dancing to music	30sec	Enjoyment
6	Watching robot dancing 2- robot dancing to music	30sec	
7	Watching robot dancing 3- robot dancing to music	30sec	Attraction
8	Watching robot dancing 4- robot dancing to music	30sec	
9	Touching robots head robot stands still	30sec	Intimacy
10	Touching robots arm robot stands still	30sec	
11	Touching robots waist robot stands still	30sec	
12	Touching robots buttocks robot stands still	30sec	
13	Touching robots inner thigh robot stands still	30sec	
14	Bursting a balloon	30sec	Highest point

Only four participants responded completely positively to questions of awareness. To six questions in the item one of dimension two, association, 70% of participants gave positive answers, while for the next item, 70% were negative in their responses.Fifty seven percent of answers were favourable to enjoyment criteria, however, only 35% thought of robots as entertainment and enjoyment (refer to Table 3).

Table 3: Results of each Dimension

Dimension	Item		Total Positive	Average
	No	Quets.		
Awareness	1	4	73	0.912
	2	10	107	0.535
Association	3	6	84	0.700
	4	3	18	0.300
Enjoyment	5	6	73	0.608
	6	4	41	0.512
Attraction	7	3	22	0.366
	8	4	21	0.262
	9	4	14	0.175
Intimacy	10	12	50	0.208
	11	12	91	0.379
	12	14	48	0.171

The level of attraction to a robot at an abstract level accumulated 36.66% favourable results. The possibility of being attracted to a robot emotionally and physically at an abstract level scored only 26.25%, while emotional attraction at a personal level garnered only 17.5% positive responses. For the dimension attraction, 79.09% answers were negative. Intimacy was the last dimension, where for three items, participants answered 38 questions, and only 24.86% answered positively.

Study 2 -

This study measured electrodermal activities (EDA) of participants when interacting with a robot. The protocols for interactions were associated with the same five dimensions as discussed above. Each participant was asked to interact with the robot in a quiet room with no disturbances, with only two researchers present. Their protocols were arranged thus (Refer to Table 2). The first and last stimuli were designed to measure the highest and lowest point in the EDA measures, so that benchmarks could be established to understand other measures. Our results revealed that each test elicited different level of responses from each participant. The benchmark we created, with the understanding that we need to position our test protocols somewhere within two spectrum, relaxation and high point of excitement, revealed that certain interactions with robots exceed those benchmarks.
In Li, J., Ju, W. and Reeves, B. [13], there was a similar study, where they measure the physiological responses to arrive at a conclusion that participants have shown a considerable higher response when touching more *low accessibility areas* of a robot. They statistically measured the response time, deciding that the response time correlated with arousal, and the results showed that response time is higher for low accessibility areas of robots body. In our study (experiment 2), the test protocols were designed according to our first study criteria, and each protocol has a response time of 30 seconds, of which the average was considered as the highest response. The awareness and association criteria

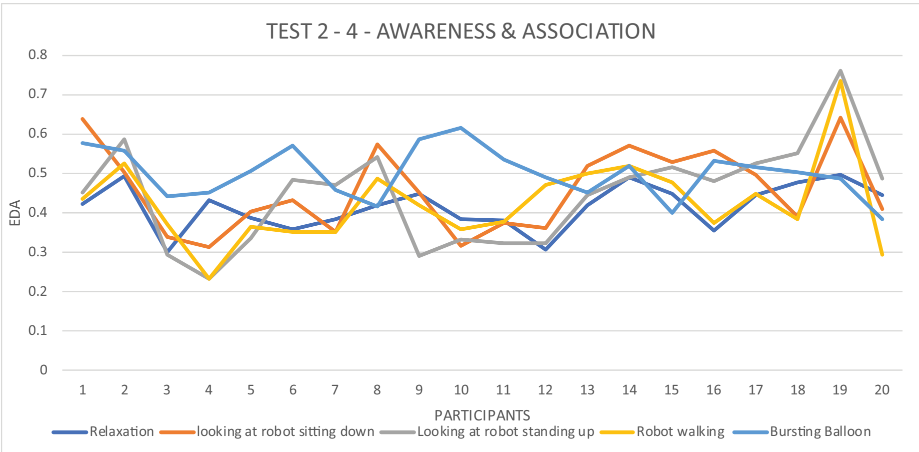

Fig. 1: Awareness and Association EDA Results of Twenty Participants

results indicated that each participant responded differently to each visual test, but not significantly (Figure 1). If we examined the participant 16, there are visible changes in response averages, however, examining the changes, the difference in the response to looking at a seated robot and a standing robot is 0.076. Three participants scored below both benchmarks, while the same number of participants scored above both benchmarks. Watching the robot dance for the first time, all participants registered an average response level of 0.499 and 6 of them gave responses below the relaxation point, which was marked as the low benchmark. The second robot dance protocol elicited an average response of 0.469 (Refer to Figure 2). Different dancing acts were selected for attraction

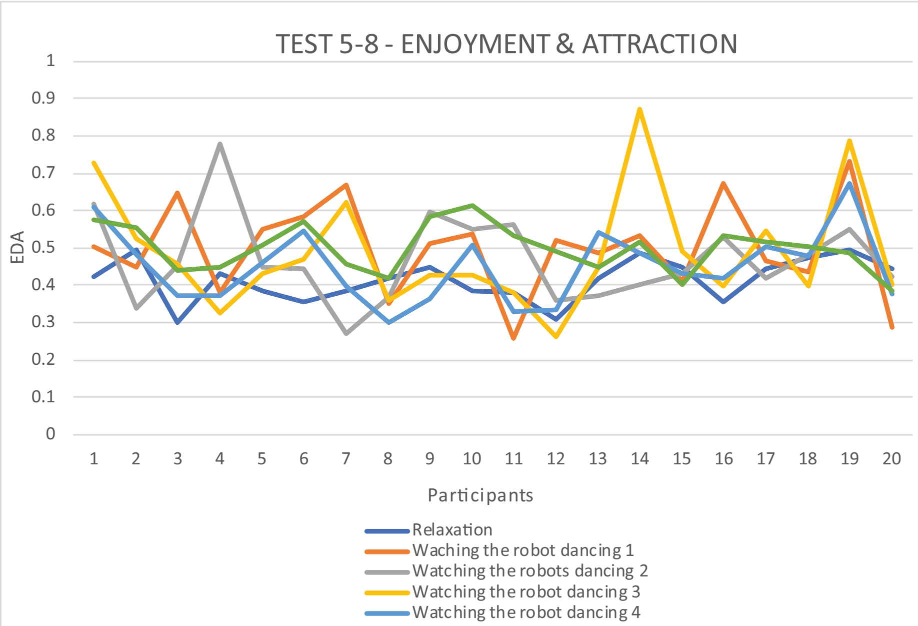

Fig. 2: Enjoyment and Attraction EDA Results of Twenty Participants

criteria (Figure 2), where the robot made intricate dance movements. The first dance move attracted an average of 0.487 response. Seven participants out of 20, exceeded the highest benchmark we imposed. The second dance by the robot received a 0.449 average response. Only three participants exceeded the highest benchmark in their responses. To cover our different categories, we have thus far introduced visual stimuli, however, for the category of intimacy we introduced touch; touching different parts of the robot (refer to Table 2 and Figure 3). It started with 3 stimuli that were impersonal touches: head, arm, and waist. It progressed to touching the robot‘s backside and inner thigh. For clarity, we separated first three impersonal touches. Touching the head of the robot had an average of 0.498 EDA response and touching the robot‘s arm and waist garnered 0.451 and 0.471 averages, respectively.

Touching the robot‘s buttocks produced an average of 0.422 EDA responses, and only 3

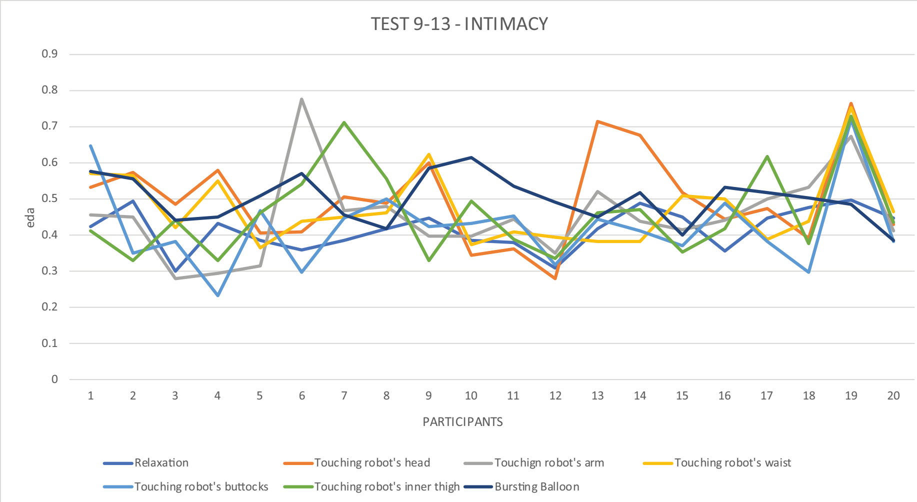

Fig. 3: Intimacy EDA Results of Twenty Participants

out of 20 participants exceeded the high benchmark we put forward. In contrast, touching the robot‘s inner thigh produced 0.460 average of response, with 7 participants exceeding the high benchmark of response, bursting a balloon. 9 participants touching the robot‘s buttocks and 6 participants touching robot‘s inner thigh produced responses that were below the low benchmark.

Although participants individually displayed EDA responses for each protocol that exceeded the high and low benchmarks responses, the averages of all participants demonstrate that high/low benchmarks are intact nonetheless. Table 4 will provide details on average responses of all 20 participants to each stimulus in ascending order.

5 Discussion

Our perceptions are constructed through social interactions, and interactions are the basis where humans understand their surrounding, be it tangible or intangible. The deeper their interactions, the more their understanding grows. Our perceptions are built through these interactions and social agreements. Connections are built through longer interactions. How we interact with robots and how we perceive them are interlinked because our perceptions influence how we interact and vice versa. Our questions on perception and informal exchange of thoughts lead us to understand certain aspects of participants perception before, during, and after interacting with the robot.

When we examined our study participants‘ awareness of robots, in any capacity, living in their space and the acceptability of their existence, 64.28% average awareness was reported. However, to questions like whether they are aware that humans want robot companions only garnered 25% of positive answers. It is revealed that our participants awareness of robots is still embedded in their comprehension of representation of robots in science fiction. They associated words of two different spectrums with robots: help

Table 4: EDA Average Ascending

Test Protocols (ascending EDA)	**Average of EDA Measures (ascending)**
1	0.414
12	0.422
4	0.423
3	0.445
8	0.449
10	0.449
2	0.458
13	0.459
6	0.469
11	0.471
7	0.487
9	0.498
5	0.499
14	0.499

and danger. Participants who answered 100% positively to this dimension saw robot as help, who perform routine and dangerous tasks in industry and help household chores in the home front. In other words, robots are mere tools, albeit more advanced ones than their dish washer. Some participants voiced future potentials, in education and healthcare, yet as tools.

Mixed answers, where participants refused to think of robot as human companions or friends, yet visualized a future of close associations with robots, were mostly founded on danger and fear. In 2005, a study conducted by Dautenhahn et al. [11] revealed that large number of the study participants were in favour of robot companions, as assistants or domestic help, but only few wanted those robot companions as friends. Considering that there are no real examples, perceiving robots as a danger is largely influenced by representation of robots in fiction. However, the fear is comprehensible when you imagine scenarios where there is a conflict of objectives between humans and robots. Consequently, it is argued that when robots learn a considerable amount of human values, they will not pose a threat [18].

The macro-micro level association the participants are building or imagined building with robots was a criterion where we wanted to establish whether their perceived connections become different from an abstract level to a personal level. Robots are created as passive machines because humans direct them in their actions. As Shibata et al. [19] pointed out robots should not be simple tools to humans merely to be evaluated objectively. An average of 56.67% participants answered positively to questions on association. 75% of participants liked robots, and 70% liked them in their homes, yet only 60% liked them in their neighborhoods. When asked about this preference from some participants, they saw robots that are not under their control, in their home, as a danger to their security. Denning et el. [20] in their study revealed that since not all are tech-savvy users, multi-robot households will face security threats. However, our participants did not voice concerns in that regard; instead they concentrated on the threats that might arise from robots controlled by others. This reveals that our perception of robots has a correlation to our perception of each other as humans.

It is revealed that perceived enjoyment has an impact on the interactions with robots [21]. For the dimension of enjoyment, overall, 57% of participants of our study answered positively. 9 out of 20 participants answered all questions positively. To questions like "do you enjoy robots" 75% agreed, yet to the statement "robots are joyous", which is attempting to establish that robots have by themselves the capacity to be joyous, was met with only 40% of positive answers. All participants are somewhat assured that they will enjoy robots, but robots having the capability to be independently enjoyable is a phenomenon they find difficult to grasp. However, the capabilities of robots as entertainers is accepted by the majority, yet doubts are prevailing on the subject of robots as joyous entities, that could, given the capability, be able to create, provide, and experience joy.

One of the prevailing issues with regards to the idea of a robot as an intimate part of everyday living is the appearance of the robot; the appearance will dissuade humans from bonding with robots. Anthropomorphic robots are inclined to be more accepted as attractive and intimate than robotic machines. As Donald Norman [22] says, beautiful things work better and make people feel good. Only 25.9% of our participants consider the possibility of being attracted to robots of any form or manner. The perception of robots as mere machines, thus tools for use, is the predominant sentiment that discourage thinking of robot differently. To argue the point that robots are indeed different, like every human being as individuals, might appear to point out the obvious rational argument, yet all of the study participants' first reaction is 'what is there to be attracted to a robot when it looks like a machine. Writing about uncanny valley, Mori [23] reflected that humans will not feel an affinity with robots unless they look less similar to machines and more like humans. However, he further argues that if a robots appears to be very similar to humans in looks, it might develop a revulsion. 60% of our study participants found robots attractive, however only 25% thought they can be attracted to a robot. 25% imagined being attracted to a robot emotionally. Shibata et al. [19] maintain that designing robots that interact with humans required the understanding of how people think of robots subjectively. On the same wavelength Hanson et al. [24] express that for the robots to be attractive to humans, integrated social 'responsivity' and aesthetic enhancements are essential. Interactions between humans and robots largely depend on the human expectations of those interactions.

When humans evaluate robots, they assume both the observer and the subject roles says [19], thus the intelligence of the robot depends on the intelligence prevailed in the subject. When humans imagine the robots as intimate partners, or robots in intimate scenarios, the perception is not only influenced by real life human-human interactions, and perception of those, but also the interpretation of human-robot relations as a subject. The morality of building intimate interactions with a non-human entity encroaches upon the notion of the sacrosanctity of being a human. As raised by Scheutz and Arnold [25], what are the moral and ethical foundations upon which these connections will be built? How will these intimacies relate to human-human intimacies? Will human beings somehow be replaced by these man-made, yet foreign, entities? In our study only 24.9% of participants accepted a possibility of intimacy with robots. Understandably our study

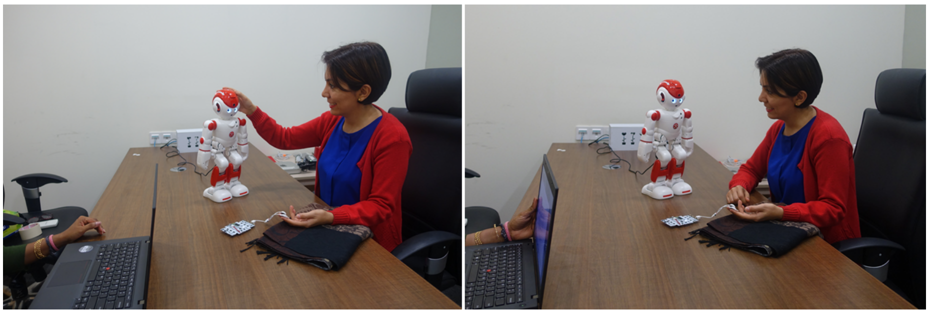

Fig. 4: Participant Interacting with the Robot

participants' imaginations have to be stretched to its fullest to comprehend and then relate to intimate scenarios with robots. Considering that their exposure to robots are limited, and the robots with high AI capabilities are still in future scenarios, imagining robots and humans in meaningful physical and emotional bonding is challenging. However, our participants found emotional bonding less disturbing than physical bonding through intimacy and sex.

Li, J., Ju, W. and Reeves [13], in their statistical analysis of EDA measurements when touching a robot, revealed that touching the intimate regions of the robot's body elicited a higher response than pointing at the those body regions. Jinnai et al. [26] claimed that more humanlike device, the human communication is more intimate. Our interactions with robots are a product of our perspectives, and there are numerous factors that influence our perceptions; both internal and external. Some external factors may influence the perception, thus impacting the physical interactions. It is argued that, irrespective of positive or negative, low motivational intensity (ie. amusement) expands the cognitive scope, than high motivational tendencies (ie desire) [27]. According to Gable and Harmon-Jones [28], high levels of arousal will not impact the motivational intensity, even though arousal and motivational intensity are connected. This encourages us to think that physiological responses may not always align with perceptions. Higher physiological responses will not necessarily indicate a change in cognition towards intimacy with robots, however, it will encourage the individual to be familiar with robots.

Our study of electrodermal activity (EDA) when interacting with a robot, revealed that on an average, watching the robot dancing protocol attracted the highest response (see Table 4 and 5). This is the first time in this study the participants encounter the robot moving to music in dancing motion. Touching the robot's body for the first time (the head) elicited the second highest response. Lowest responses were produced by the protocol that invite participants to touch the robot's buttocks.

Our test design focused on visuals and haptics (Refer Figure 4). Visual was intended to create the notion of familiarity, an awareness of the robot as an entity with humanoid appearance that can accomplish certain activities, prompting communications. Those tests were expected to encourage the participants away from the notion of robots as a mere machines, and instead positively evaluate the abilities and potentials of robots. Visuals lead to haptics, which will be instrumental in understanding the physiological response to touching a robot.

Fig. 5: Participant Interacting with Visual and Haptic Stimuli 1

Our results revealed that there was no clear difference between responsiveness towards visual stimuli, intended for influencing the perception of robots and haptic stimuli where regions of the robot‘s body that is deemed as private and intimate were being touched (refer to Table 4). The highest score, when participants are watching the robot dancing was understandably significant, not only because that was the first experience of a dancing robot to the participants, but also because the act of dancing could enliven the disposition. When the dancing entity is a robot, with its mechanical body, moving as smoothly and coordinated as possible, a perceptive change is created. In the same manner participants react to the sound of the bursting balloon, a dancing robot create an excitement that is physiologically measurable.

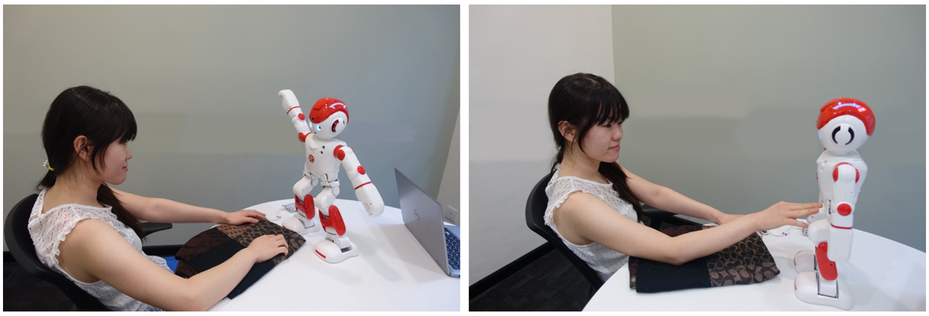

Fig. 6: Participant Interacting with Visual and Haptic Stimuli 2

The first encounter of touching the robot‘s private and intimate regions of the body began with touching the head. Participants average reactions were highest in the haptic category. Touching the robot‘s waist, second highest score in haptics revealed that private yet less intimate regions of the robot‘s body elicited a higher response. However, the difference between touching the head and waist is 0.270. In comparison, the difference between the highest and lowest scored stimuli was 0.774. Touching robot‘s inner thigh scored higher than touching the buttocks, the difference being 0.037. The difference in responses is unexplainable, because it is difficult to make the assumption that the inner thigh is considered less intimate than the buttocks. However, when asked informally after the tests, they did not voice specific emotions like embarrassment or awkwardness when touching the intimate regions of the robot‘s body, instead they expressed the strangeness of the act itself. Perceptions are basically socially constructed; thus, it is problematic to conclude that each visual and haptic stimuli directly revealed a position. However, we would like to proposition that, even though for comprehensive analysis we considered all participants as an aggregate, considering individual responses with their study 1 results will produce an in-depth understanding of the subjective responses to human-robot interactions.

We have presented two different tests: one to understand perception of human-robot interactions, how they position themselves within the human and robot sphere, and another to measure their physiological responses. The first test revealed that perception of robots in any capacity is considerably built on media consumption. This was later clarified during informal discussions we conducted with participants. Whether it is human-robot romantic involvement, or powerful and aggressive robots (or hybrid creatures) invading the planet, these visual imageries are playing a leading role in conceiving the human-robot relationship. All the robots in contemporary everyday life, be it a mechanical arm, domestic service robots, entertainment robots, or sex robots, are such an extension to everyday living that we failed to notice the roles they play; the role of helping us. Yet our imagery has this evil entity that threaten the human values. A robot in an intimate setting is unimaginable to the majority because their fear of the unknown (known only through media depictions) is represented in the concept of human-robot interactions.

Lack of awareness of future possibilities in robotics, and human-robot relationships has created a void in most participants. Creating future scenarios, in terms of potentials developments in human-robot intimacies, were also decidedly influenced by the concept of creationism, the moral unacceptability of altering the belief in human creation.

The perception of human-robot interactions and physiological responses to interacting with a robot (visual/haptic) have not been examined in this study to build a correlation, which will require a different methodological approach; instead we examined them in terms of the positioning of human-robot interactions. It is revealed that participants demonstrated mixed responses to touching perceived intimate regions of a robot‘s body. They have not revealed a significant high response when touching the most intimate part, instead displayed a lowest average for one of the most intimate parts of the robots body, the buttocks. The highest response recorded for touching the robot‘s buttocks was the participant whose positive responses to perception questions were only 40.24%. The participant whose responses recorded as the lowest for touching the robot‘s inner thigh, produced 93% of positive answers for perception of human-robot interactions.

Our conclusions at large;

1) For the future, it is highly significant to create a greater awareness through continuous

Table 5: Visual and Haptic Stimuli

Protocol category	**Stimuli**	**Stimuli (ascending)**	**Average of EDA (ascending)**
Visuals	Relaxation audio/video relaxation	1	0.414
	Watching robot moving robot walking	4	0.423
	Looking at the robot robot standing up	3	0.445
	Watching robot dancing 4- robot dancing to music	5	0.449
	Looking at the robot robot sitting down	7	0.458
	Watching robot dancing 2- robot dancing to music	9	0.469
	Watching robot dancing 3- robot dancing to music	11	0.487
	Watching robot dancing 1 robot dancing to music	13	0.499
Haptics	Touching robots buttocks robot stands still	2	0.422
	Touching robots arm robot stands still	6	0.449
	Touching robots inner thigh robot stands still	8	0.459
	Touching robots waist robot stands still	10	0.471
	Touching robots head robot stands still	12	0.498
	Bursting a balloon	14	0.499

media exposure of various developments in the field of robotics and artificial intelligence. Awareness will create a mindfulness of robotic technology as more than machinery and algorithms, and advancement in robotics will prepare humans to think in terms of inclusivity.

2) Scenarios of future robotics technology and human-robot relationship are build and developed with information gleaned from robotic and AI-related research, and fictional depiction of human-robot relations. Robotic, AI, and human-robot interaction research expand the conversation of the repertoire of future human-robot developments.

3) Human-robot relations are based on fear (mingled with hope) and benefits. Fear of machines overpowering humans has been in the conversation from way back when automated manufacturing was introduced and recently in the form of mobile phones, internet, and media consumption. Robots, somehow, were revealed as entities that work, taking over repetitive, dangerous, and mundane tasks. Even though our participants were concerned about the loss of jobs to robots, thus increasing the unemployment, they have little conception of the incredible amount of jobs robots are already involved in and will be handling in coming decades.

4) Intimacy with robots is inconceivable to most because of the resolute belief that humans ought to be intimate with only humans, although sex robots are a thriving commercial industry. The morality of intimacy, especially the intimate act of sex, with a robot will always be subject of intense discussions.

5) Visuals and haptics in the interactions with robots revealed mixed physiological reactions. Most of the participants inclined towards enjoying the robot in various dance moves than haptics, although they revealed a higher response when touching the robot for the first time. This inadvertently exposes that our interactions with robots will be non-linear and multifaceted, not necessarily because humans are complex, but also because AI will create a complexity of a different nature. It will be two different yet, somehow similar dimensions making compromises, creating new set of shared values.

6 Limitations

As limitations, we understand that our sample size of 20 participants is inadequate to argue a broader element. We will eliminate this weakness in our next study where we will add a third stage to the study, a qualitative analysis. We understand that, for a very complex subject, we let participants give binary answers in study one. That might not have given us a comprehensive perspective from the participants, however, we addressed that by having an informal exchange with each participant for this study. For the extended study, which we will be conducting as the next stage of this study, we are intending to incorporate open ended interviews with each participant.

7 Conclusion

In this study we discussed the perception of being intimately associated with robots and physiological reaction through EDA measurements to a number of stimuli that created intimacy with a robot. The majority of the participants of the study revealed they are aware of robots (largely due to media depiction of robots), however, they have reservation about being intimate with robots. They collectively saw robots as machines, even with the possibility of AI changing that status. The symbolic representation of robots as machines affected the way they associate robots with emotions and intimacy. Their physiological responses showed that their reactions are higher for visual stimuli of a robot moving to music, than for haptic stimuli.
It can be understood that the participants were primarily driven by the knowledge that robots are mere machines, which is permissible considering current developments in robotics and AI are progressing slowly. But in another decade, advancements in artificial intelligence, and experiments in humanoid robots will create an entity that is beyond a machine. Future robots will demonstrate capabilities somewhat equal to humans, which will create a strong friction that is triggered by the fear of being overpowered. Every participant of this study voiced their fear of future robots, either as a threat for employment or as a major threat to the humankind.
As future developments in this study, we will incorporate an open-ended interview, taking all participants as an aggregate, as well as individuals.

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